Final Report for NASA Grant NAG5-2429

Multiwavelength Studies of Her X-1

P.I.: Saeqa Dil Vrtilek
co-Is: Dr. J. Trümper, Dr. P. Kahabka, Dr. W. Voges, Dr. K. Dennerl, & Dr. P. Serlemitsos

UM account # 01-5-26201 - Technical Officer Rob Petre, Code 666, NASA Goddard Space Flight Center, Greenbelt, MD 20771

The ROSAT observations were part of an extensive multiwavelength campaign of the X-ray pulsar system Her X-1/HZ Her conducted in 1993 August. The source was found in an anomalous low state detected only once before. A substantial, unexpected drop in flux at X-ray energies, with no change in absorbing column density; an increase in the pulse period from the previous measurement, contrary to the usual spin-up; no pulsed emission above 0.9 keV; and optical fluxes that continued to show 1.7 day modulation attributed to X-ray heating of the companion star are characteristics observed during anomalous low states. The 1993 campaign also detected a significant reduction in UV flux during eclipse ingress and egress. Comprehensive modeling of the ultraviolet and optical continuum flux suggests that the ultraviolet and optical lightcurves can be reproduced by assuming variations in mass-accretion rate alone; however, changes in accretion rate are insufficient to account for the observed drop in X-ray flux. Shifts in disk inclination angle *and* changes in mass accretion rate can consistently explain the observed changes in X-ray, ultraviolet, and optical fluxes. The changes in mass accretion rate and disk inclination angle may be related to shifts in the 35-day precession period, with the average mass accretion rate corresponding to the average 35-day period. The rapid fluctuations in soft X-ray flux observed several times during the campaign may be caused by rapid variation of the mass accretion rate.

To date a total of eight publications (refereed papers and conference reports) have resulted utilizing data obtained in connection with this grant, a ninth is in preparation.

Multiwavelength Observations of Hercules X-1 (S.D. Vrtilek, P. Charles, E. Hu, P. Kahabka, H. Marshall, T. Mihara, F. Primini, R. Rutten, Y. Soong, J. Stull, & W. Voges). Evolution of X-ray Binaries, College Park, MD, Oct 11-13, 1993.

Simultaneous Multiwavelength Observations of Hercules X-1 (S.D. Vrtilek, P. Charles, E. Hu, P. Kahabka, La Dous, C., H. Marshall, T. Mihara, F. Primini, R. Rutten, Y. Soong, J. Stull, J. Truemper, W. Voges, R. Wagner, & R.M. Wilson 1993, *B.A.A.S.*, 25, 1346.

Multiwavelength Observations of Her X-1: A Simultaneous Look at 4 Decades of the Spectrum (S.D. Vrtilek, P.A. Charles, K.O. Dennerl, E. Hu,P. Kahabka, C. la Dous, H. Marshall, T. Mihara, F.A. Primini, J.C. Raymond, R. Rutten, Y. Soong,J. Stull, J. Trümper, W. Voges, R. M. Wagner, R. Wilson). IAU Symposium 165, Aug 15-19, 1994. The Hague, Nederlands.

Observations of Hercules X-1 with IUE: Ultraviolet Results from a Multiwavelength Campaign (S.D. Vrtilek, F.H. Cheng, & J.C. Raymond). Joint Meeting of the APS and the AAPT, 19 April 1995. Washington, D.C.

An Improved X-ray Heating Model for Her X-1 (F.H. Cheng, S.D. Vrtilek, & J.C. Raymond), IAU Colloquium 158, June 15-30th, 1995, Keele, England.

Multiwavelength Observations of Hercules X-1/HZ Herculis S.D. Vrtilek *et al.*), 1994, *ApJLetters*, **436**, L9.

Accretion Disk Dynamics of Her X-1 (S.D. Vrtilek), in proceedings of IAU Colloquium 158, June 15-30th, 1995, Keele, England.

The UV/Optical Continuum of Her X-1/HZ Her (S.D. Vrtilek & F.H. Cheng), ApJ, 465, July 10, 1996 issue.

ROSAT Observations of Her X-1/HZ Her During a Multiwavelength campaign (P. Kahabka, F. Primini, S.D. Vrtilek, J. Tr/"umper, W. Voges, & K. Dennerl) in preparation.